

CHROMOSOME NUMBERS IN THE HIGHER PLANTS.—A few months ago, while browsing through the book reviews in the last issue of the "Quarterly Review of Biology," my eye was caught by the statement that ". . . one half of all the ferns and flowering plants are of polyploid origin. . . ." ¹ That statement seemed to me to be unscientific; unscientific, because I did not believe that available data would substantiate the quantitative part of the assertion; unscientific, because we do not have the historical knowledge of plant genera and species which the word "origin" implies.

This statement did prompt me to turn my attention to the "Chromosome Atlas of Flowering Plants" ² by Darlington and Wylie, which purports to (and probably does) summarize our knowledge of chromosome number in the gymnosperms and angiosperms. This book supplies the raw data on which statements about relative abundance of chromosome numbers in these two groups may be based. Though it is only a compilation—and subject to all the faults that pertain thereto—it fills a definite need. It deserves the attention of systematists, taxonomists—and geneticists. In order to see what the facts bearing on the preliminary statement might be, I sat down with the "Atlas . . .," an adding machine, and a few books of reference. The following figures were the result.

According to the best estimate available, ³ there are, in the world today, about 250,700 species of angiosperms and gymnosperms. Of these, about 720 are gymnosperms, 200,000 are dicotyledons, and 50,000 are monocotyledons. Darlington and Wylie record that in these three groups representatives of some 15,000 species have been analyzed. This constitutes about 6% of the total number of species known. A count of the data given shows that about 5,000 species, or $\frac{1}{3}$ of the total number analyzed, give evidence of a polyploid chromosome number. Thus, to date, about 2% of the total number of species of higher plants have been proved to have polyploid representatives. This can hardly be construed as ". . . one half. . . ."

On using the "Chromosome Atlas of Flowering Plants," one is impressed by a number of rather significant tendencies. Perhaps the most striking is the large number of chromosome counts which appear to be based on but a single report—or, alternatively, the number of species with a stable chromosome number. By my count, only about 1,700 taxa, or 11% of the number analyzed, are recorded with two or more different chromosome numbers. A second bias is the geographical limitation of origin of these reports, the vast majority from western Europe, temperate North America, India and Japan.

One is impressed, also, by the large number of species of economic importance which have been reported on. The taxonomist will remember

¹ Quart. Rev. Biol. 31 (2); 133, June, 1956.

² Darlington, C. D. and Wylie, A. P.—Chromosome Atlas of Flowering Plants—London, Allen and Unwin, Ltd. 1955. pp. 519.

³ Jones, G. N. on the number of Species of Plants. Scientific Monthly, 72 (5): 289–295. May, 1951.

that plants in cultivation are not necessarily characteristic of the wild populations, morphologically or cytologically, and that identifications of cultivated material—including plants in botanic gardens—are not infrequently of dubious validity. Likewise, a significant proportion of the species appears to be native in temperate regions. It will be remembered that such plants are, at least occasionally, exposed to conditions of, for them, extreme cold. It will be remembered that this is one of the conditions which have been known to induce cytological abnormalities.

One is impressed by the paucity of reports on tropical plants. This, despite the fact that speciation is probably more fully developed in the tropical rainforest than in the temperate zone. For instance, the *Orchidaceae*, a predominantly tropical family, is well known for extreme variation of floral morphology. It is a family estimated to contain more than 15,000 species—more than the number of species that is recorded in the "Atlas" for all of the higher plants. However, apparently only about 195 species (or 1.3%) of the orchids have been studied cytologically. Of three orchidaceous genera, any one of which contains more than one thousand species, counts are recorded for only eight species of *Dendrobium*. Six species of *Epidendrum*, and no species of *Bulbophyllum*.

The orchids are not alone in not having been studied. The *Convolvulaceae*, with an estimated 1,650 species in 55 genera,⁴ are represented in the "Atlas" by 51 species (3%), in 14 genera of which about 16 appear to be polyploids. The genus *Ipomoea*, estimated to contain about 500 species,⁴ is represented by only 11 species (2%), of which possibly four species are polyploids. The *Palmae*, with a world census of about 1500 species in 200 genera,⁵ is represented in the "Atlas" by about 78 species (5%) in 50 genera. No polyploids seem to have been recorded. The *Proteaceae*, with about 1300 species in 60 genera,⁴ are represented by 36 (3%) species in 24 genera. There appear to be about 11 polyploids recorded. The *Flacourtiaceae*, likewise with about 1300 species in 84 genera,⁴ are adumbrated to the extent of 6 species (.5%) two of which are polyploids in three genera. The *Dioscoreaceae*, with 600 species in 9 genera, are represented by some 20 species (3%) with 14 polyploids in 3 genera.

This is not to imply, however, that plants of the temperate zones have been exhaustively studied. The *Compositae*, for instance, which include some 13,000 species in 900 genera,⁵ have been studied to date to the extent of 852 species (7%) in 199 genera. There appear to be some 300 polyploids. The genus *Senecio*, with an estimated 2,000 species,⁵ is represented by counts of 38 species, (2%) 36 of which seem to be polyploids. It would seem incautious, however, to assume that 94% of the genus is polyploid on the basis of such a scanty sample. The *Umbelliferae*, an admittedly intricate family taxonomically, are reputed to include about 2,700 species in 200 genera.⁵ To date we have counts for 187 (7%) species in 79 genera. Twenty-four polyploids have been reported.

⁴ Flora Malesiana, Series I, vols. 4 and 5.

⁵ Willis, J. C. Dictionary of the Flowering Plants and Ferns, Ed. 6. Cambridge (repr. 1948).

The *Gramineae* is said to include about 4500 species in 450 genera. Of this number, some 1350 species (30%) in 255 genera have been analyzed. Somewhat over 900 of the species seem to be polyploids. This is a proportion significantly higher than the average for the rest of the higher plants. Indeed, comparisons may be made only with genera such as *Sedum* or *Salix*. It would seem that conclusions based on this apparent divergence from the normal should await the accumulation of considerably more data than are available at present.

The *Leguminosae* is a particularly instructive family from the viewpoint of chromosome numbers. In the sixth edition of Willis's "Dictionary of the Flowering Plants and Ferns" the family was credited with about 600 genera. Recent estimates of the number of genera, published in the "Flore du Congo-belge" approximate the figures given by Willis.

The legumes are customarily divided into three sub-families or families. Two of the groups (*Mimosoideae* and *Caesalpinioideae*) which account for about 200 genera and 2500 species are predominantly tropical. The third group (*Papilionatae*) accounts for the balance—some 400–425 genera and about 10,000 species. It is predominantly temperate or warm-temperate in distribution.

Taking the *Mimosoideae* and *Caesalpinioideae* together, the "Atlas" accounts for 47 genera (about 23%) and 204 species (about 13%). My count gives 52 polyploids, or about 25% of the species analyzed. This would seem a far cry from the alleged one half.

We turn now to the sub-family *Papilionatae*, which comprises an estimated 400 genera and 10,000 species. It is predominantly temperate and warm-temperate in distribution. It includes at least 15 genera with more than 100 species. The largest genus, *Astragalus*, has about 1600 species. Many of the species of the sub-family have an economic importance. If cytological analysis had progressed to any great length, one would be inclined to think that this sub-family should give an excellent test of the correlation of polyploidy with speciation. Study of the "Atlas" reveals the following:

TRIFOLIUM is a genus of about 290 species. The "Atlas" records counts for about 40 species, with 8 polyploids. With two exceptions, all of the species are reputed to be used for forage. 28 of the species are listed as European in distribution. In the area covered by Hegi, about 200 species are recorded. 6 of the reported species are reputed to be native in western North America. Abrams accounts for 54 species in part of the same area.

LUPINUS is a genus of about 150 species. The "Atlas" records counts for 22 species, of which nearly all are polyploids. Five species are attributed to Europe. Hegi lists 28. Nine are referred to the west coast of this country. Abrams records 84. One might note in passing that the common *Lupinus perennis*, widespread in the eastern United States is not recorded.

DESMODIUM is a genus of about 170 species, strongly developed in the tropics and sub-tropics. Counts for 11 species are recorded in the "Atlas." Five of the species fall within the "Grays Manual" range. Schubert, in Fernald, accounts for 24 species. No polyploids have been recorded.

ASTRAGALUS, as noted above, is a genus of about 1600 species. The "Atlas" records 5 species, one of them a polyploid, from western North America.

Abrams records 140 species. Five species in the "Atlas" are attributed to the "Grays Manual" range. Fernald records 25 from the same area. Nine or ten species are referred to Europe. Hegi records about 100 species. Fourteen species are supposed to be Asiatic. The Flora URSS records 849. "The Flora of British India" records 70 species. Altogether the "Atlas" records 35 species.

We must thank Drs. Darlington and Wylie for this compilation, for it shows us very clearly how little we know about chromosome numbers in plants. The "Chromosome Atlas of Flowering Plants" is a valuable statement of progress—but we must not misconstrue it as a final report. I fear that the vast majority of the figures reported here are based upon samples that are statistically meaningless. They can, indeed, be taken only as a very general indication of what we might expect to find should we chose to investigate more fully. In no sense may these reports be treated as though they were axioms of Euclidian geometry. We need to know a great deal more about populations, and about species, and about genera before we use these facts, or any related facts, in any large scheme of speculation. We can neither affirm nor deny that . . . "half of all the ferns and flowering plants are of polyploid origin." We can only say that present evidence does not lend much credence to this assertion.—GORDON P. DEWOLF, JR.

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